WELDING AND MELTING OF γ-TiAl INGOTS USING ELECTRON BEAM TECHNOLOGY

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Alloys on the base of γ-aluminides are regarded as a promising material for making components of hot section of gas turbine engines with a working temperature of 700 - 950 ^{o}C.

Main drawback of these alloys is low ductility at a temperature of up to 700°C, which dramatically decreasing their general workability.

The purpose of this study was to determine the feasibility EBW of γ-aluminides, and find technological solutions to ensure properties of welded joints close to those of the base metal and to estimate applicability of the electron beam technology for melting ingots of titanium alloys on the γ–aluminide base.Alloy of the 47XD grade (50Ti-46Al-2Nb-2Mn) was used as the base metal for the studies.

As shown by the calculations, cold cracks in welding the 47XD alloy were caused primarily by longitudinal stresses formed in a welded joint at the stage of cooling.

It was shown that even at a preheating temperature of 400 ^{o}C the level of residual stresses did not exceed the level of tensile strength at a normal temperature. Therefore, the welded joint in this case should have no crack.

The experiments fully confirmed the calculation results.

The technological process of EBW of the 47XD alloy should comprise preheating of parts to be welded to a temperature of 400-500°C in order to avoid formation of cracks in the weld and heat-affected zone, as well as postweld annealing of welded joints at 800°C for 10 minutes in order to decrease the level of residual stresses and ensure strength of the welded joints equal to that of the base metal. Both preheating and postweld annealing should be performed using a defocused electron beam directly in the welding chamber.

The assembly-welding fixture for welding γ-TiAl alloys should provide relatively free temporary strains of a part along the weld axis.

Experimental melting of ingots (165 mm diameter, 30 kg weight) of alloy Ti-47Al-2Nb-1.5Cr (at. %) was carried out using the UE-208 machine. The ingots were produced by double remelting of the charge consisting of titanium sponge of the TG-110 grade, commercial-purity aluminum, electrolytic chromium and niobium.

Samples for chemical analysis were taken along the length of an ingot at a depth of 10 mm from the ingot surface and in a radial direction (across the ingots) on a template. No macro segregation both in longitudinal and transverse directions was detected.